AUTOMATIC SORTING MACHINE

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ABSTRACT

The automatic sorting system has been reported to be complex and a global problem. This is because of the inability of sorting machines to incorporate flexibility in their design concept. This research therefore designed and developed an automated sorting object of a conveyor belt. The developed automated sorting machine is able to incorporate flexibility and separate species of non-ferrous metal objects and at the same time move objects automatically to the basket as defined by the regulation of the Programmable Logic Controllers (PLC) with a capacitive proximity sensor to detect a value range of objects. The result obtained shows that various materials were sorted into their respective and correct position with an average, sorting, time of 9.903 s to 14.072 s. The proposed developed model of this research could be adopted at any institution or industries, whose practices are based on mechatronics engineering systems. This is to guide the industrial sector in sorting of object and teaching aid to institutions and hence produce the list of classified materials according to the enabled sorting program commands.

Belt conveyors a kind of the machine that is used to transfer material continuously. The belt works under the effect of frictional force. The belt conveyor is simple in structure, easy to maintain, its transfer capacity is high, transfer distance is long they are widely used in mining, metallurgical and coal industries. The main objective of this project is to build a unique kind of algorithm to achieve a new kind of approachability n the field of automation in industry. These machines can do different work at different places without man. We in our project designed an automatic object rejection system to reject the defective object when it comes by the conveyor system.

Keywords – *Automated Sorting, conveyor system, Programmable Logic Control, Automation.*

1. INTRODUCTION

Materials handling involves the movement, storage, control, and protection of materials during their manufacturing, distribution, consumption, and disposal there are different material handling systems and equipment in industrial plants, which use conveyor system. It moves objects from the source to the terminal instead of moving objects with people due to its ability of continuity in the operation speed and consistency of objects in movement. Material handling systems ranges from simple pallet rack, shelving projects to complex overhead conveyor systems, automated storage, and retrieval systems. Material handling also consists of sorting and picking. In recent times, various sorting systems have been developed. The applications of sorting varies from agricultural products, consumer manufactured products, books, etc. Constantine and Michael in 2002 reported that every sorting methodology can be classified based on the specification of two issues: (1) the form of the criteria aggregation model which is developed for sorting purposes, and (2) the methodology employed to define the parameters of the sorting model. Few researches were also based on automatic sorting, manual sorting and online sorting methods. For example, few researchers proposed sorting system that can organize different material automatically without human aid, with the use of double acting pneumatic cylinder to push the material to its equivalent boxes on the conveyor belt Other methods are the dielectrophoresis, morphological transformation of labeling of materials, magnetophoresis, fluorescence activated image segmentation .These proposed sorting methods however, have

various problems attributed to them. For example, poor sorting efficiency, energy demand, multi-tasking and machine flexibility. In other to rise above the shortcomings of ever increasing sorting efficiency of materials, conserved energy and improve quality productivities, automatic sorting methods were proposed by various researchers .This work proposed and based the model on the automatic sorting techniques. The aim of this research therefore is to design a model and simulate the functionalities of an automatic sorting machine using a capacitive proximity sensor. In order to achieve these developed automatic sorting methods, the images of the objects (i.e. plastics, wood and steel) were captured with the proximity sensor and the conveyer belt transports the material from one point to another. The conveyor system automatically sort objects in such a way as to increase product manufacturing, quality control and profit making enterprises. It is important to know that, these proposed sorting methods however, have various problems attributed to them. For example, poor sorting efficiency, energy demand, multi-tasking and machine flexibility. In other to rise above the shortcomings of ever increasing sorting efficiency of materials, conserved energy and improve quality productivities, automatic sorting methods were proposed by various researchers .This work proposed and based the model on the automatic sorting techniques. The aim of this research therefore is to design a model and simulate the functionalities of an automatic sorting machine using a capacitive proximity sensor. In order to achieve these developed automatic sorting methods, the images of the objects (i.e. plastics, wood and steel) were captured with the proximity sensor and the conveyer belt transports the material from one point to another. The conveyor system automatically sort objects in such a way as to increase product manufacturing, quality control and profit making enterprises. It is important to know that The conveyor belt could be automated by allowing the objects to move to the detection position through the dynamics of the running motors. Using the sensor signal to control in this project we have designed the special pneumatic system to automatically reject and pass the object. In this project we use one motorized conveyor belt for material movement line. It is very useful for production industries and material handling department etc.

1.1 Problem statement

The problem statement for the project is to create the electronic material handling system which can be used to reduce the effort of the workers as well as to reduce the time spent in the inspection of the components, during their manufacturing .it also reduces the effort in transferring the component manufactured to another workstation. The most apparent reason that is associated in installing of automatic system in industries is;

1. Saving man power
2. Improved quality and efficiency.

1.2 construction of unit

Detailed procedure of fabrication of the project and use of different machines:

1. Gas cutting:-The scrap material which was an angel used for frame is firstly cut into desired length. As the material was in welded condition, we have used the gas cutting method for ease of cutting.

2. Band saw cutting:-Now we are having all the scrap material as per the requirement in the design. After referring the drawing the detailed dimensioning for the material available is made and the available scrap material is cut using the band saw cutting machine.

3. Preparation of frame:-The angle and c channels are arranged as per the drawing. The frame is now welded using oxy-fuel welding is done. Now the frame is ready.

4. Fabrication of the shaft:-The available bearing and required rotation, power requirement etc gave overall structure of the shaft. We have prepared the temporary drawing of the shaft and then we have fabricated the shaft on the lathe machine.

5. Preparation of the sub frame:-After the preparation of the frame, we have prepared the sub frame for the driving unit. This frame is used for drive unit.

6. Adjustment for the tension of the belt:-For the adjustment of the tension of the belt, the appropriate sized nut bolt is fitted which gives the desired tension adjustment.

7. Preparation of the drive unit: Now the pulleys are brought as per the drawing, and after the fitting pulleys to shafts, for v-belts are taken and then they are adjusted over the pulleys.

8. Building a conveyor belt:-Now the main conveyor belt is built on the drums, then required tension is provided using adjustment of the nut – bolt assembly.

2. Experimental Component

2.1 Pneumatic cylinder-Single-acting cylinders (SAC) use the pressure imparted by compressed air to create a driving force in one direction (usually out), and a spring to return to the "home" position. More often than not, this type of cylinder has limited extension due to the space the compressed spring takes up. Another downside to SACs is that part of the force produced by the cylinder is lost as it tries to push against the spring.

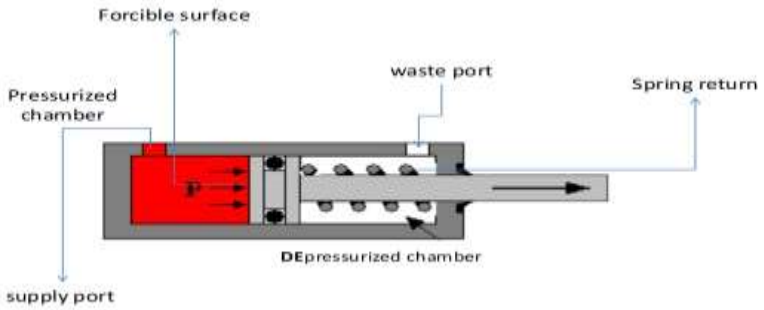


Fig. no.1: Pneumatic cylinder

2.2 Pneumatically actuated 3/2 DCV- The cross-sectional views of pneumatically actuated NC type 3/2 DCV in normal position and actuated positions are shown in the Figure.

When the compressed air is applied through the pilot port (12), the spool is moved against the spring. In the actuated position, the working port (2) is open to the pressure port (1) and closed to the exhaust port (3). Thus, the application of the compressed air to the port 12 causes the pressure port (1) to be connected to the working port (2). Pneumatically actuated valves have following.

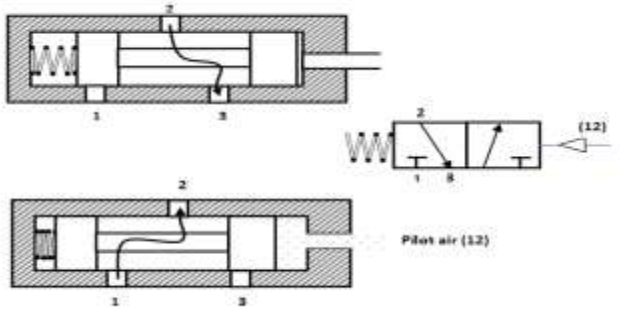


Fig no.2 3/2 DC Valve

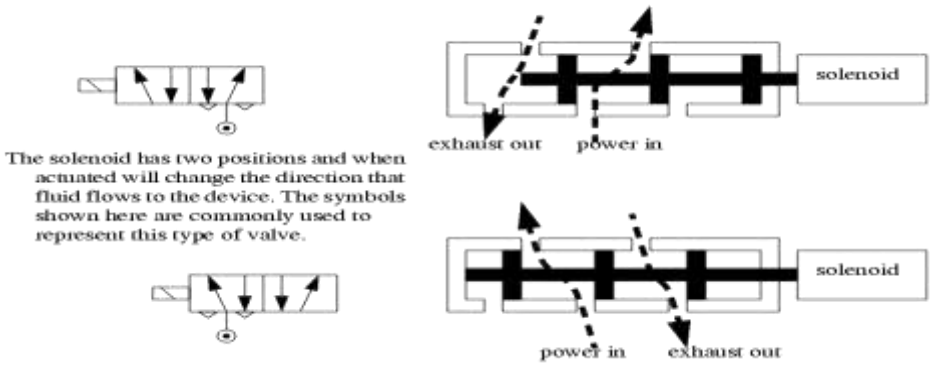
2.3 Two stage air compressor- Double stage or two stage reciprocating air compressors consist of two cylinders. One is called low pressure cylinder and another is called high pressure cylinder. When piston in low pressure cylinder is at it's outer dead center (ODC) the weight of air inside cylinder is zero (neglecting clearance volume), as piston moves towards inner dead center (IDC) pressure falls below atmospheric pressure & suction valves opens due to pressure difference. The fresh air is drawn inside the low pressure cylinder through air suction filter**.** This air is further compressed by piston and pressure inside & outside the cylinder is equal, at this point suction valves closed.

As piston moves towards ODC compression of air took place and when the pressure of air is in range of 1.5 kg/centimeter square to 2.5 kg/centimeter square delivery valves opens & this compressed air is then entered into high pressure cylinder through inter cooler. This called as low pressure compression. If suction & discharge stroke took place on both side of piston then it is called Double Acting Low pressure compression. Suction valves of high pressure cylinder opens when air pressure in high pressure side is below to the receiver pressure & air from low pressure cylinder drawn into high pressure cylinder.

As piston moves towards the ODC, first stage air is further compressed. When air pressure from low pressure cylinder and inside the high pressure cylinder is equal, suction valves closed. Now air is further compressed by piston until the pressure in the High Pressure Cylinder exceeds that in the receiver & discharge valves opens. This desired high pressure air is then delivered to receiver.

Fig no.3 Two Stage Air Compressor

2.4 Solenoid Valve-Solenoid is a simple electromagnetic device that converts electrical energy directly into linear mechanical motion, but it has a very short stroke (length of movement), which limits its applications.



2.5 Motor-30RPM Centre Shaft Economy Series DC Motor is high quality low cost DC geared Motor gives 30 RPM at 12V but motor runs smoothly from 4V to 12V and gives wide range of RPM, and torque. Tables below gives fairly good idea of the motor's performance in terms of RPM and no load current as a function of voltage and stall torque, stall current as a function of voltage.

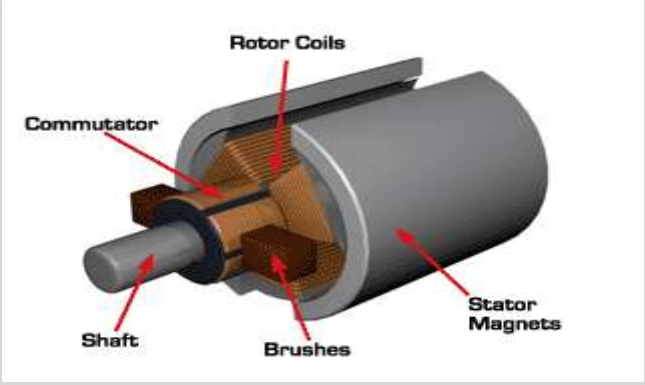


Fig no.4 DC Motor

2.6 Belt Conveyor- A conveyor belt consist of two or More pulleys, with a continuous loop of material which rotate over the. One or both of the pulleys are powered, moving the belt and material on the belt forward. There are two main industrial classes of belt conveyors; those in general material handling such as those moving boxes along inside factory and bulk material handling such as those used to transport industrial and agricultural materials, such as grain, coal, ores, etc.

The design of belt conveyor systems has been one of the most common occurrences in the South African mining field for over one hundred years. Conveyors are seen on virtually all mining installations, and are the biggest problem for the plant maintenance engineer, being the cause of most plant shutdowns.

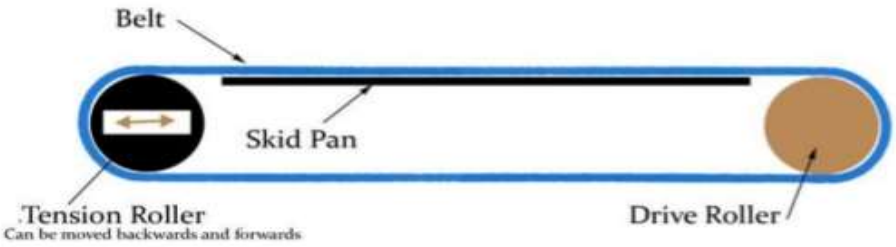


Fig no.5 Conveyor Belt

2.7 SENSOR

Proximity sensor:

A proximity sensor is a sensor able to detect the presence of nearby objects without any physical contact. A proximity sensor often emits an electromagnetic field or a beam of electromagnetic radiation and looks for changes in field or return signals. The object being sensed is often referred to as the proximity sensors target demand different sensors. Proximity sensors can have a high reliability and long functional life because of the absence of mechanical parts and lack of physical contact between sensor and sensed object.

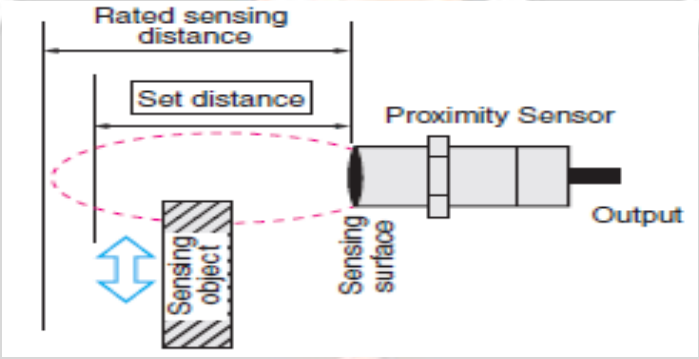


Fig. No. 6 Proximity Sensor

Limit switch: A Limit switch is an electromechanical device that consists of an actuator mechanically linked to set of contact. When an object comes into contact with the actuator, the device operates the contact to make or break an electrical connection, limit switches are used in a verity of application environments because of their ruggedness , simple visible operations, each of installation and operational reliability

Fig No. 7 Limit Switch

3. DESIGN OF COMPONENTS AND CALCULATIONS.

Table1. Selection of kY factor based on Belt length, lift and capacity.

Length	Lift	kY	kY	kY	kY
m	m	500t/hr.	1000t/hr.	2000t/hr.	3000t/hr.
100	20	0,035	0,030	0,026	0,022
200	20	0,032	0,026	0,022	0,020
200	40	0,030	0,022	0,020	0,020
400	20	0,030	0,022	0,020	0,020
400	40	0,026	0,020	0,020	0,020
800	40	0,022	0,020	0,020	0,020
1000	40	0,020	0,020	0,020	0,020

To enable the client to maintain control of the outcome of the calculation, it is necessary only to specify the kY factor to be used in a simple addendum to the main specification. Belt tension calculation can be kept straight forward, provided the designer starts by considering the minimum belt tensions, at both the drive and tail pulleys, by using the following formulae :-

Tmin = 4, 2x9, 81/1000 si(Wb+Wm) kN
Where 4,2 = Factor based on a 3% belt sag.
Si = Idler spacing,m
and
Tslack side = Teffective / e -1

Where T effective is the installed drive effective tension and not the effective tension computed from the above power formula.

3.1 Design and Friction Calculations.

Motor pulley Diameter = 20 mm.

IP –Shaft Pulley Diameter = 110 mm.

Reduction Ratio = 5

Coefficient Of Friction = 0.23

Maximum Allowable Tension in Belt = 200 N

Centre Distance = 762 mm

= 180- sin^-1(D-d)/ 2C

=180- sin^-1(110-20)/ 2× 200

=136º

=2.37º

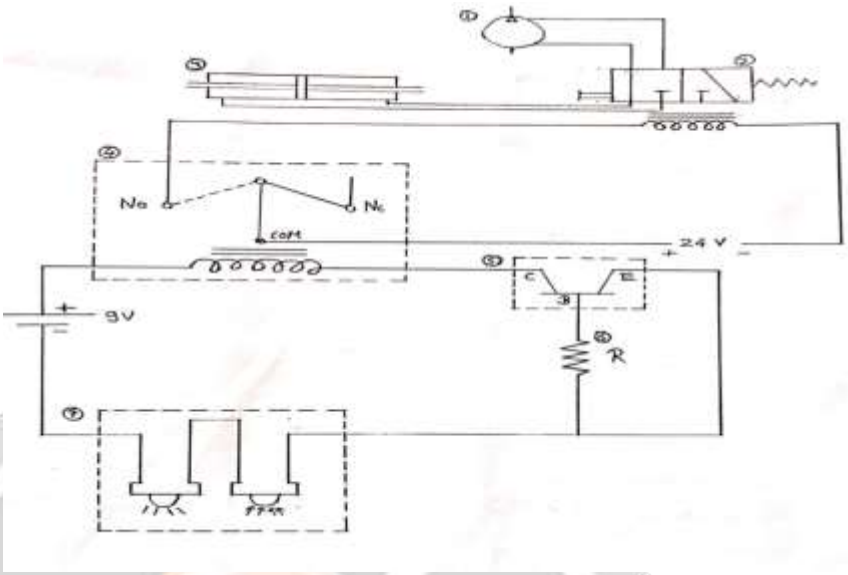
Now,

Width at Base is Given By: b= 6-2(4 tan 20) = 3.1

Area of Cross section of belt; =1/2(6+3.1) ×4 =25.4 mm

3.2 Total Control Circuit

(1) h Compressor
(2) 3/2 Solenoid valve
(3) Double acting cylinder
(4) Relay
(5) NPN Transistor
(6) Resistor



Where,

No – Normally open

NC- Normally closed

R – Resistor

C – Collector

B – Base

E - Emittor

3.3 Observations and data collection

The table below shows the sorting time in seconds for the number of trials respectively
Table of Trials

No of trials	1	2	3	4	5	6	7	8	9	10
Time in sec	5	4	5	4.5	5	5.5	4.5	5	5	5

Table 2 Trial table

3.4 Results

The result obtained show that for the 10 trials of materials sorted using the capacitive proximity sensors for the same materials under investigations each object were sorted correctly into the designated compartment however, each of the trial time varies in sorting trial.

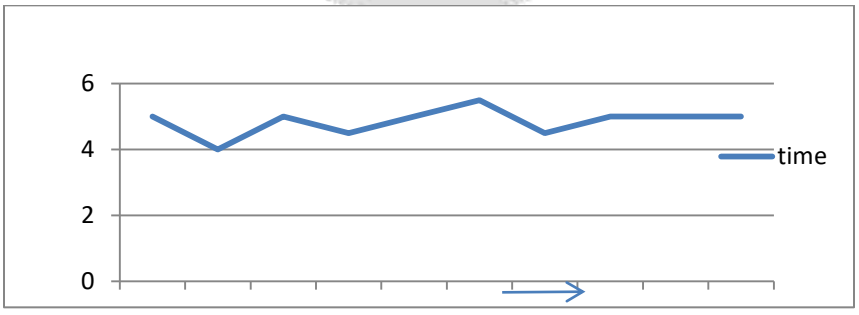


Chart 1 response time

4. CONCLUSION

The proposed methodology of modeling the sorting machine in this work can be adopted and extended to evaluate and model other types of sensors that could be applicable for sustainable sorting of different objects. This work is a fundamental approach to modeling manufacturing and automated machines. It is observed that irrespective of the type of sensors used, the proximity distances of the sorting sensors plays a vital role in determining the time it takes for sorting. In general, it is recommended that capacitive sensors be used for sorting of complex manufacturing of objects with different chemical properties. The following conclusion can be deduced from this work:

1. Since the trial objects were sorted successfully, the sorting sensors, conveyors and other accessories were proper for sorting machine modeling.

2. It is also observed that the control unit is necessary for the controlling of the sorting machine. This is because it is the 'brain' of the sorting system to execute the required functions.

3. Each object was sorted correctly into the designated compartment with an average sorting time of 5seconds.

4. Depending on the torque of the DC gear motor, the weight of the sort material has little or no effect on the movement towards the conveyor belt and sort time however it is recommended that further analysis be carried to evaluate this hypothesis.

5. The driving range and the speed of the object depend mainly on the control of the control unit and the sensitivity of the sensor that could be adjusted to a suitable distance between object-sensor detection distances.

6. It is recommended that this model be extended to include other types of sensors and objects of different material (i.e. different chemical properties) to ensure repeatability and model consistency.

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